Unmanned Aircraft Systems:

Human Factors Issues

Nancy J. Cooke, Ph.D.

Arizona State University

and

Cognitive Engineering Research Institute

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Sources

[Research](#) at ASU/CERI on UAS Command-and-Control

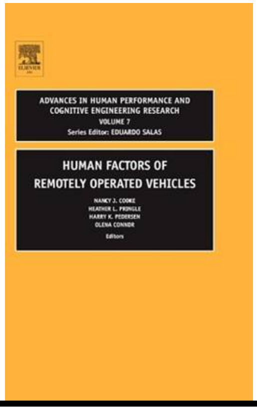
Human Factors of UAVs

"Manning The Unmanned"

Human Factors of UAVs Workshops (2004-2007): operators, HF researchers, engineers/developers

Cooke, N. J., Gesell, L.E., Hartman, J., Pack, W., Pederson, H., & Skinner, M. (2006). *Human Factors in Unmanned System Training*. Technical Report for NASA sponsored Unmanned Aerial Vehicles Alliance, Research and Curriculum (UAV-ARC) Development Partnership Project.

Cooke, N. J., Pringle, H., Pedersen, H., & Connor, O. (Eds., 2006). *Human Factors of Remotely Operated Vehicles*



Interactions with UAV Battlelab, AZ Air National Guard, Ft. Huachuca Army Research Lab, Nellis AFB, ERAU, Kutta

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Human Factors of Unmanned Systems?

- UASs have been reported to have a high mishap rate--by some counts 100 times higher than that of manned aircraft (Jackson, 2003)
- 33-43% of the mishaps to human factors issues (Schmidt & Parker, 1995; Seagle, 1997).

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Some Human Factors Issues Implicated

- Loss of situation awareness
- Operational tempo/fatigue/workload
- Poor teamwork/handoffs/lack of communication
- Command-and-control chain inefficient
- Remote control with poor feedback
- Crew selection & training
- Aeromedical readiness
- Pilot proficiency/currency
- Personnel shortages

UAS Myths

MYTH #1: UAS is unmanned

- Operators are remote, not absent
- Ground personnel are numerous (1-5 Global Hawks require 28 maintenance personnel in theater; Army estimates staffing at 70 per vehicle)

MYTH #2: UAS is a vehicle

- A system that includes the vehicle, the ground control station, and the payload which is typically part of a larger system
- "Flying the camera," rather than flying the vehicle.

MYTH #3: UAS flight is like manned aviation

There are similarities

- Human navigates and controls position and speed of vehicle
- Landing and take-off are difficult tasks for both platforms

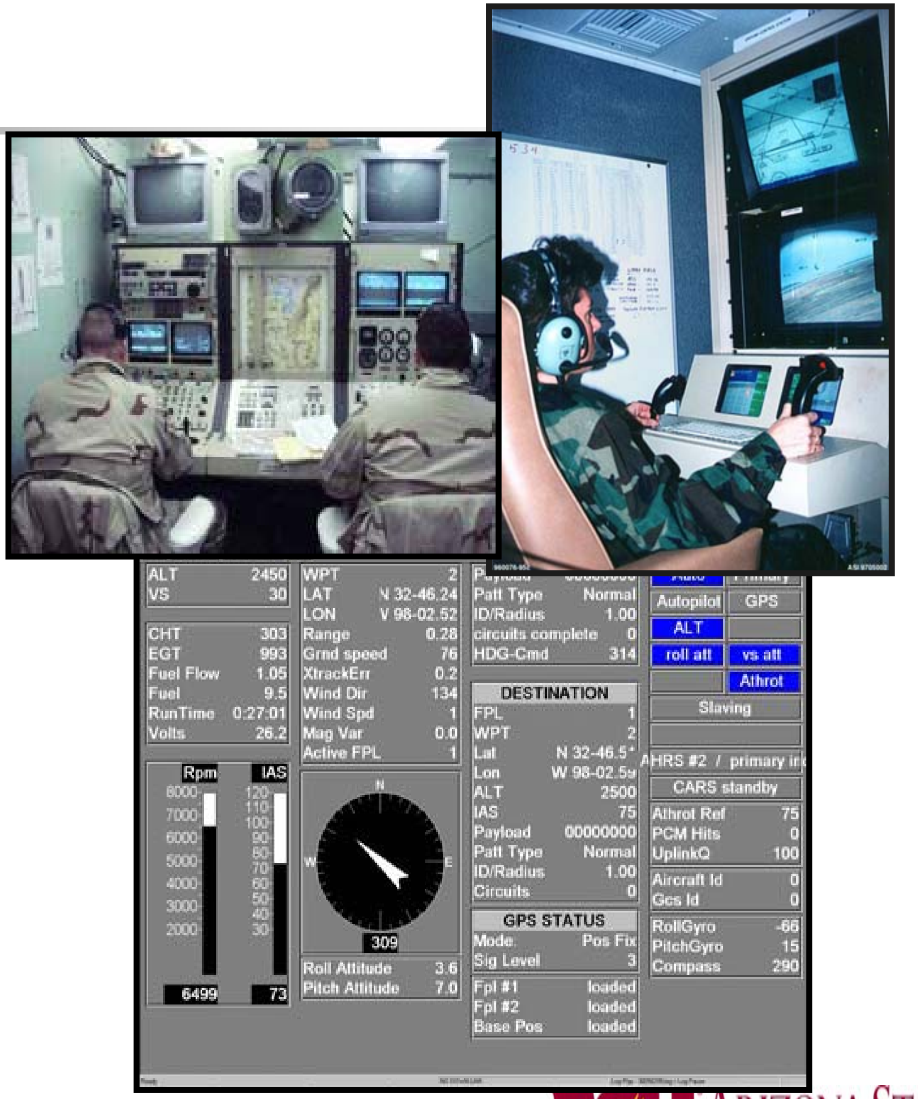
There are big differences

- Sensing and control occur remotely

Human Factors Issues

Human-Machine Interface

- Stick-and-rudder control schemes (Predator) vs. point-and-click (Global Hawk and Shadow)
- Poor display configurations
- Excessive modes
- Incompatible control-response mapping
- No standard interface



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Remote Sensing and Control

- Perception occurs through sensor displays
- Visual experience of a UAS pilot - looking at the world through a soda straw
- There is lack of presence – no motion or tactile feedback
- Significant delays between control and vehicle response
- As a result...
  - Landing difficulties – Predator nose-mounted flight camera is not on a gimbal, the pilot loses sight of the runway until the UAS touches down
  - Limited ability to perceive weather changes
  - See-and-avoid difficulties
  - No seat-of-the-pants flying
  - Loss of situation awareness, spatial disorientation
- Ongoing Research...
  - Improved sensors
  - Synthetic overlays and enhanced displays
  - Possible motion and tactile feedback

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Spatial Disorientation

- UAS operators can become spatially disoriented
- Visual perception limited by the camera angle
  - Lack of visual flow due to poor displays
  - SAR and Infrared displays
- Visual perception is exacerbated by being physically removed from the feedback of the vehicle
  - Visual-vestibular mismatches
- Difficulty in discerning objects and judging distances between objects (especially at night)
- UAS mishaps, particularly at the time of landing, have been attributed to problems of spatial disorientation

Automation & Multi-UAS Operation

- Problems with Automation
  - Automation changes the human's task- Overseer
  - Loss of situation awareness
  - Trust in automation (misuse, disuse, over-reliance)
  - Breakdowns in automation
- Workload
  - Workload is not constant: "intense boredom with snippets of extreme terror"
  - Workload differs by roles, platforms, & mission objectives
  - Workload tends to be greatest when a target is reached and when re-planning occurs
- Multi UAS operations
  - Typically 2 operators (pilot and sensor operator): 1 UAS
  - Current multi-UAS platforms maintain 1 sensor operator per UAS

Multiple UAS control may be possible with very high degrees of automation or when all vehicles are in a normal point-to-point state of flight. However, when the situation changes, when a single UAS is in trouble, or when a target is reached, multiple UAS control by a single individual could range from difficult to impossible.

Fatigue

- UAS operators often called upon to work long shifts
- Environmental stressors
- High workload
- Vigilance task
- Interruption of circadian rhythms
- Lack of sleep
- Lack of operational standards

Crew Coordination and Communication

- Some UAS mishaps attributed poor teamwork
- Crew handoffs in midair common
- Predator take-offs and landings handled by different crews than mission crew

Remote ground operation of UASs requires multiple distributed individuals and increases communication and coordination requirements

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Training

Training should not be a fix for poor design

- Lack of standards for pilot qualifications
  - Army systems (Hunter, Shadow UASs) piloted by individuals trained to operate a UAS, but not a manned aircraft
  - Air Force's Predator operators are trained Air Force pilots of manned aircraft.

- Unclear knowledge, skills, and abilities associated with the task of operating a UAS
  - Compatible with instrument flight conditions of manned flight (i.e., little or no visual feedback)
  - New skill set required– ability to project into the remote environment.

- Training & Certification issues and research questions:
  - Determine knowledge, skills, and abilities necessary for UAS operation.
  - Identify common ground across services, platforms, airspace, and mission
  - Identify most effective training method or hybrid of methods
  - Determine empirically whether manned flight experience is a necessary prerequisite to UAS training, and if so, the type and extent of ground school/ flight training necessary
  - Determine value of prior experience operating remote-controlled airplanes
  - Determine importance of video gaming experience
  - How should performance be assessed?
  - How instructors should be trained?
  - What distinguishes competency from expertise?

Social Implications

- Pilotless planes in the NAS
- Passenger planes w/o a pilot
- Remote termination in the military
- Privacy issues – “spy planes”

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Conclusions

- UASs are not unmanned
  - For effective, safe systems, it is essential that human capabilities and limitations be considered early in system and training design
- UASs are systems, not vehicles
  - Certification and air worthiness assessment needs to include ground control station
- Gaps in R&D
  - Interfaces for improving remote sensing and control and increasing operator situation awareness
  - Understanding limits on automation and multiple UAS control
  - Improved teamwork
  - Training based on requisite knowledge, skills, and abilities
- The technology is available; proper human systems integration is missing
  - Common ground across platforms
  - Connection to operators and developers

Questions or Comments?

Nancy J. Cooke

ncooke@asu.edu

www.certt.com

ncooke@cerici.org

www.cerici.org

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